Water Quality Trading in Ontario

By Richard McNeil, for Environment Probe
May 2013

Water quality is a pressing issue in many of Ontario's watersheds. Four of the five Great Lakes border the province, and more than a quarter of a million lakes, rivers, streams, and groundwater sources are contained within it. Numerous lakes and rivers suffer from poor water quality, particularly in basins with significant agricultural, industrial, and/or municipal development (Sustainable Prosperity, 2011). Improving water quality in such areas can benefit public health, the environment, and the economy.

In recent decades, provincial regulators and conservation authorities have begun seeking alternatives to the current methods of mitigating water pollution. An increasingly popular alternative is Water Quality Trading (WQT). In a typical WQT system, a regulator sets a water pollution limit for a watershed and allows polluters within that watershed to find the most efficient ways to reduce overall emissions. Those with higher pollution reduction costs can purchase pollution credits from those with lower pollution reduction costs. WQT incorporates economic instruments into water management, creating financial incentives to reduce pollution. These tools tend to complement, rather than replace, conventional environmental regulations.

This paper explores the benefits associated with WQT. It examines the theory behind WQT, reviews common practices where trading has been introduced, and identifies principles for effective programs. Finally, it presents two Ontario case studies: the South Nation River watershed, where WQT has been a success, and the Lake Simcoe watershed, where WQT is currently being considered.

Water Quality: The Challenges

In Ontario, the *Environmental Protection Act* makes it unlawful to discharge contaminants into the natural environment in excess of levels permitted by regulations. The law has been applied primarily to point source polluters – those, such as factories and wastewater treatment plants, that discharge into a waterbody via a discrete source. The province has largely used command-and-control regulations to address water quality issues, requiring point sources to update their pollution abatement technologies to meet standards and enforcing these standards – albeit inconsistently – through the use of monetary fines (Ludwig, 2004). This command-and-control approach is often criticized as being inefficient and has had only limited success in improving water quality.

Unfortunately, non-point source polluters are not subject to the same emission standards as point sources (Weersink et al., 1998). Pollutants from non-point sources include runoff from municipalities, farms, and golf courses, the accumulation of which can contribute significantly to a watershed's quality problems. Such pollutants, being difficult to measure, have eluded traditional regulation. A command-and-control approach to non-point source pollution has been seen as ineffective, costly, and politically unpopular. Regulators have instead tended to implement voluntary programs offering grants and other forms of aid to non-point sources to reduce emissions. These programs have had only limited success. Public funding has been modest, and polluters have been hesitant to opt in to voluntary programs when they have no legal obligation to internalize environmental costs (Weersink et al., 1998).

WQT helps address the problems associated with reducing pollutants from both point sources and non-point sources. It seeks to improve upon command-and-control regulation, allowing private industry and municipal polluters to meet or surpass regulatory compliance levels and save money on the costs of doing so. It does not allow polluters to buy their way out of emission reductions, but instead spurs innovative and efficient approaches to reducing pollution (Horne, 2008; Environmental Defense, 2000). WQT also helps to eliminate the government's role in funding pollution reductions from non-point sources.

Successful programs implementing WQT can be found throughout the United States (Yandle, 2008, Earles et al., 2008, Hamilton, 2006), but remain rare in Canada – one notable exception being the South Nation River watershed near Ottawa. WQT's proven record as a cost-effective means to improve water quality suggests that the approach could benefit other watersheds in Ontario, as well.

Water Quality Trading: The Theory

WQT involves using market forces to improve water quality in rivers, streams, and coastal waters where command-and-control, point-source regulation has failed to resolve water quality issues (Selman et al., 2009). WQT is a cap-and-trade regulatory system, which sets an allowable limit on a desired contaminant and allocates emission credits to the polluters involved. Emission credits allow polluters to emit a certain volume of a contaminant each year. Annual water quality goals require emission reductions for a watershed as a whole, but allow individual polluters the freedom of reaching that goal in the most cost-effective way possible. This type of system gives entities an incentive to reduce emissions before a deadline, in order to sell and make a profit from their pollution reductions in the form of emission credits.

Using this cap-and-trade mechanism has been successful in obtaining cost-effective reductions in other areas of environmental concern, such as acid rain. The Acid Rain Program in the United States reduced sulphur dioxide (SO_2) emissions from a selection of power plants (Chestnut & Mills, 2005). The program allowed SO_2 emitters with lower pollution reduction costs to earn credits by reducing emissions below their compliance standards. Through reducing emissions, polluters could profit from selling their earned credits to other emitters with higher pollution reduction costs. The large emitters could buy enough credits to offset their annual reductions without facing major fines, allowing them to reduce overall emissions for a fraction of the cost. The annual benefits of the Acid Rain Program were estimated at US$122 billion and the annual costs at US$3 billion, which translates to a 40:1 benefit-cost ratio (National Association of Clean Air Agencies, 2005).

WQT and the Acid Rain Program are similar in that they are both based on the fact that the costs to reduce pollution differ among individual sources depending on their size, location, scale, management, and overall efficiency. Trading allows sources with higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution discharge reductions (in the form of credits or allowances) from sources that have lower pollution control costs. When sources with cheaper pollution control methods reduce their discharges beyond regulated or permitted levels, they can sell their excess credits to sources with more expensive control methods (Selman et al., 2009). This results in a lower overall concentration of the targeted contaminant, at a lower cost to everyone involved. In addition, economists (Baumol and Oates, 1988) and environmentalists (Faeth, 2000) believe that water pollution control technologies will improve as polluting entities have more freedom to invest in and explore different means of pollution reduction (Horne, 2008).

Water Quality Trading: The Practice

WQT systems will differ as each watershed has varying proportions of point and non-point sources of pollution. This is easily understood: As no two watersheds are exactly the same, no two trading systems will be either. Careful research and planning is required to establish WQT systems that allow the market to reduce pollution levels.

Open and closed systems

When a system is restricted to a specified number of participants, it is referred to as a "closed" system (United Nations Environment Programme, 2002). Closed systems are typically proposed for trading in areas with a large proportion of contaminants coming from point sources. The Acid Rain Program is a good example of a closed system as the majority of SO_2 emissions could be traced to a handful of power plants.

A trading system that allows participants to use emission reductions from sources other than the original participants is known as an "open" system (United Nations Environment Programme, 2002). Open systems are more common in WQT as a large proportion of water pollution can be attributed to non-point sources, as is the case in the Great Lakes Basin (Great Lakes Quality Board, 1989). Open systems allow polluters – often non-point source polluters – to "opt-in" to the trading program if they expect to be able to reduce their emissions cheaply and wish to sell credits to sources having emission compliance problems. These new participants can earn credits to sell by implementing emission reductions projects that have been deemed sufficient by regulatory agencies, typically conservation authorities in charge of the overseeing market transactions (United Nations Environment Programme, 2002).

Market structures

Market structures define how trading occurs and what infrastructure is used to support the WQT program (Selman et al., 2009). Emission trading markets fall into four main categories: exchanges, bilateral negotiations, clearinghouses, and sole-source offsets. WQT programs seek to achieve a high level of environmental success while remaining cost effective. Having more market options allows flexibility in ensuring those goals are met.

Bilateral negotiations. A bilateral negotiation market structure is characterized by one-to-one negotiations, requiring substantial interaction between the buyer and the seller to exchange information and negotiate the terms of trade (Woodward et al., 2002). A price is typically arrived at through a process of bargaining and not simply by observing a market price. Bilateral negotions generally result in high transaction costs. Bilateral negotiations are closed system trading schemes and have occured between two point sources or a point source and a non-point source.

Sole-source offsets. Sole-source offsets occur when sources are allowed to increase their discharges from one location if they reduce their discharges elsewhere, resulting in the same net amount of pollution reduction for a lower price. This type of water quality management does not involve trading at all and results in very low transaction costs as the responsibility for achieving success remains with the single source.

Clearinghouse. A clearinghouse market structure uses an intermediary to link buyers and sellers of credits. Regulated facilities purchase credits from the intermediary, who uses these funds to purchase credits generated from pollution reductions throughout the watershed. A clearinghouse simplifies transactions, as buyers and sellers avoid having to locate and purchase credits on their own. Clearinghouse market structures can be open or closed trading systems, and typically involve a combination of multiple point and nonpoint sources.

Exchange market. An exchange market is characterized by buyers and sellers meeting in a public forum with all commodities being equivalent and all prices transparent (Selman et al., 2009). Exchange markets reduce transaction costs, though the initial cost of infrastructure for communication and enforcing trades is more significant. The market for SO_2 allowances is the clearest example and has resulted in a fluid and growing market that moves SO_2 polluting rights from one source to another at very low cost (Schmalensee et al., 1998). Exchange markets are open trading systems and facilitate trading between both point and non-point sources.

Principles for effective water quality trading

Analyses of past and proposed WQT programs suggest a number of factors that contribute to their success or failure. Effective programs tend to be:

Accountable. Mechanisms should be in place to demonstrate that pollution reductions from trades are actually achieved.

Beneficial. WQT should result in net water quality benefits.

Defensible. WQT parameters, such as credits and ratios, should be based on reliable scientific evidence and methods.

Economical. Reductions in pollutant loadings that result from WQT should come at an overall lower cost than those from traditional approaches to water quality improvement.

Enforceable. WQT rules, policies, and procedures should be simple and consistent, and participants should be aware of consequences of failing to fulfill trading obligations.

Equitable. WQT programs should seek to avoid bias in terms of participation, location of trades, and value of credits.

Flexible. Information about WQT operation and quality improvements should be periodically reviewed and used to adapt trading to changing knowledge and technology.

Transparent. WQT programs should be designed using a participatory approach involving users, planners, and policy-makers. The operation of the program should be accessible and transparent to users and the public to maintain confidence in the WQT program and its achievements.

Supported by the community. A high level of local participation and sharing of responsibility and decision making is important in influencing changes in attitudes and behavior. (The first eight principles, above, were emphasized in XCG and Keiser, 2010 and Ogilvie, 2013; the ninth comes from Dimock, 1997).

Factors that limit trading activity and can cause WQT to fail include poor program design, difficulties estimating loadings from non-point sources, and high program costs (Selman et al., 2009). Two other factors that can affect WQT are lack of regulation and lack of stakeholder interest and support for WQT (XCG and Keiser, 2010). WQT programs need to be designed very carefully to minimize the risk of a failed market and in turn a waste of resources.

Two Ontario Case Studies

South Nation River

The South Nation River (SNR) watershed, located southeast of Ottawa, has received international recognition for its WQT system (Selman et al. 2009). WQT was implemented in the SNR watershed as conventional technological upgrades by point source polluters had failed to adequately reduce phosphorus levels. This was the case as approximately 90% of the phosphorus load was contributed by non-point sources (Environment Canada, 2013; O'Grady, 2008). As municipal and industrial wastewater plants contributed 10% or less of the phosphorus load to the SNR watershed, updating techonologies had little effect on water quality as a whole.

According to provincial policy, "water quality that does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives" (Ministry of the Environment, 1994). The limit for the concentration of phosphorus in the SNR watershed is set at 0.03 mg/L, but in some areas the concentrations were found to be up to three times the limit (O'Grady, 2008). This raised concern with the Ministry of Environment, which in 1998 stopped issuing discharge permits to polluters, resulting in zero allowable development in the watershed (O'Grady & Wilson, no date). MOE imposed this standard only on new construction and allowed existing plants to continue to operate according to their current permit regulations (O'Grady & Wilson, no date).

As a zero allowable development initiative was impossible with population growth in the area, the Ministry of Environment implemented a WQT system called Total Phosphorus Management (TPM) to remove excess phosphorus contributions by wastewater dischargers (Environment Canada, 2013). TPM is an open WQT system with a clearinghouse styled market. It allows municipal and industrial dischargers to indirectly invest in the control of non-point sources of phosphorus pollution as an alternative to employing costly point source phosphorus treatments to reduce nutrient loadings (Conservation Ontario, 2003). As water quality objectives were met by implementing a WQT system in the SNR from 2000-2009, WQT only occurs currently if water treatment plants are expanding or a new water treatment plant is being built, in conjunction with the zero allowable development initiative (O'Grady, 2013A).

The South Nation Conservation Authority (SNCA) acts as a broker/clearinghouse to oversee market transactions. The SNCA uses "investments" from municipal wastewater treatment plants to fund 50%-100% of the costs of projects that reduce phosphorus pollution from non-point sources throughout the watershed. This enables the wastewater treatment plants to offset increases in pollution from their plants (SNCA, 2007). As non-point sources contribute a substantial amount of phosphorus to the watershed compared to wastewater treatment plants, the SNCA is ensuring that municipalities are using their resources much more efficiently, in effect through financing phosphorus reductions at non-point sources.

Non-point source emitters earn credits (in the form of grants) by installing approved phosphorus reduction strategies called Best Management Practices (BMPs), which include but are not limited to upgrading septic systems, manure storages, and milkhouse wastewater systems, controlling or diverting barnyard runoff, and preventing livestock access to water sources (O'Grady, 2011). Purchasing BMP credits reduces cost uncertainty for point sources, making the program more desirable for them.

To take into account nutrient-flow uncertainty in the best management practices, an agreed upon offset-ratio was established between the wastewater treatment plants, the SNCA, the farmers, and other emitters constructing BMPs. This ratio ensures that phosphorus reductions are guaranteed throughout the watershed as fluctuations in weather patterns cause variable flows of phosphorus. A ratio of 1:1 would require treatment plants to offset 1 kilogram of annual phosphorus emissions at non-point sources per 1 kilogram of annual emissions produced at wastewater treatment plants. With the use of a higher ratio, the uncertainty of the flow of contaminants into the watershed can be accounted for. A 4:1 offset ratio was negotiated for in the SNR watershed, requiring 4 kilograms of non-point source phosphorus (measured as total phosphorus) be removed annually for every kilogram of phosphorus contributed annually by point sources (Kassirer, 2013).

In a unique variation from other WQT systems, the SNCA hired farmers to act as field representatives to promote and oversee best management practice completion. This allowed the agricultural community to build trust in WQT, which encouraged more farmers to apply for grants to build BMPs on their property (O'Grady, 2013A). The field representatives would then make presentations to the Clean Water Committee (composed of farmers, industry, municipalities, farm organizations, and SNCA), who ranked projects based on improvements to water quality and decided which projects to fund. All criteria, grant rates, and other water quality decisions were made by the Clean Water Committee (O'Grady, 2013A).

MOE commissioned Cullbridge Marketing and Communications to conduct an independent evaluation to determine the overall benefits of the trading program, and not just as it related to achieving reduction targets (Kassirer, 2013). As of 2009, 269 TPM projects had been completed, generating approximately 11,843 kilograms of phosphorus reductions (SNCA, 2010). The greatest reductions stemmed from upgrading manure storages, which accounted for 73% of reductions, or 8,546 kilograms of phosphorus (SNCA, 2010).

The economic benefits of implementing WQT can be understood through a comparison of the costs of using the TPM program to those of upgrading wastewater treatment plants. The data in the following table was taken directly from engineering reports on phosphorus reductions in the SNR watershed (O'Grady, 2013B).

Municipality	**TPM Removal Target (kg/yr)**	**TPM Cost**	**Approx. Cost for Treatment for Phosphorus Removal**	**TPM Cost Savings**
North Stormont – Finch	225	$80,400	$225,000	**$144,600**
North Dundas – Winchester	640	$192,000	$640,000	**$448,000**
Casselman	1282	$384,600	$1.2 million	**$815,400**
Nation – Limoges	772	$127,612	$1.5 million	**$1.37 million**

Source: SNCA, 2009

The program evaluation also included a telephone survey, in which 89 landowners were contacted and 68 responded. The vast majority of participating landowners were satisfied with the program, with 85.7% already recommending the program to a friend or neighbour. Another question asked, in the opinion of the participants, what improvements have resulted through the implementation of trading. This question was unprompted, meaning that no options were given and answers were spontaneous. Over 40% noted improved soil quality, improved herd health, and money saved; over 60% referred to a reduced health risk to their families; over 70% indicated an increased respect for the environment and an improved opinion of SNCA; and nearly 80% identified an increase in the value of their property (Kassirer, 2013).

Lake Simcoe

Lake Simcoe is in need of protection. Municipalities, septic systems, and farms have degraded its water quality and impaired its ecological health. The province passed the Lake Simcoe Protection Act in 2008, providing authority for a Lake Simcoe Protection Plan (LSPP) to restore a self-sustaining coldwater fishery and increase water quality as a whole. Phosphorus has been found to be a causal factor in the degradation of Lake Simcoe's water quality. One of the objectives of the LSPP has been to reduce loadings of phosphorus and other nutrients of concern into the lake's tributaries (Ministry of the Environment, 2009).

Phosphorus loadings need to be reduced to a level of 44 tonnes per year to achieve the target water quality objective, and municipalities have been working hard over the past 20 years to reach this target. Under the Lake Simcoe Water Quality Improvement Program, municipalities have reduced phosphorus inputs by retrofitting stormwater ponds, undertaking stream bank erosion control projects, inspecting sewage treatment plants, reporting effluent concentrations, and decommissioning and/or replacing septic systems throughout the Lake Simcoe watershed (Ministry of the Environment, 2009). As a result, phosphorus loads have decreased from over 100 tonnes/year in the early 1990s to an average of 70 tonnes/year in 2006-2007. The development of a WQT system in the Lake Simcoe watershed has been proposed and is currently being discussed as a potential tool to further improve water quality (Walters, 2013).

In February 2010, the Ministry of the Environment released a feasibility study on the applicability of WQT to the Lake Simcoe watershed, conducted by XCG Consultants (XCG and Keiser, 2010). Three conditions needed to be met to deem the program feasible. The conditions were: 1) well-defined sources and amounts of pollution that could be traded; 2) incentives through regulation to encourage trading; and 3) varying pollution reduction costs to allow trading to occur (XCG and Keiser, 2010). All of these conditions have been satisfied. The Lake Simcoe Assimilative Capacity Study provided information about phosphorus loading and behavior; the regulatory requirements contained in the Phosphorus Reduction Strategy proposed by the Ministry of Ontario can create incentives to encourage trading; and a trading opportunities analysis supports the possibilities of an economically viable market, where demand would exceed the supply of available credits (XCG and Keiser, 2010). Given that the criteria exist for a feasible WQT program, the next challenge to be overcome is getting public support for the program. A survey conducted in 2012 for the Lake Simcoe Region Conservation Authority revealed that 20% of the respondents didn't know enough about WQT to decide if it was a good idea for Lake Simcoe (Ogilvie, 2013). The firm conducting the survey subsequently produced a paper aiming to garner support for WQT in Lake Simcoe and to foster a pilot trading arrangement (Ogilvie, 2013).

WQT would benefit the Lake Simcoe watershed by giving provincial regulators and the Lake Simcoe Region Conservation Authority an extra tool to combat poor water quality. As the 14 municipal and 1 private wastewater treatment plants contribute less than 5% of the total phosphorus pollution in the watershed, upgrading these entities would be an ineffective use of resources (Walters, 2013). Targeting sources that contribute the most phosphorus to the lake would greatly improve water quality, and allow water treatment plants to save money in the process.

Conclusion

Water quality has improved across Ontario due to technological upgrades at municipal wastewater treatment plants and industrial facilities, but these improvements have been insufficient. Since municipal and industrial point sources contribute a limited portion of the pollution in many watersheds, technological upgrades have had a limited effect on waterbodies as a whole.

Ideally, non-point sources of pollution would be regulated as strictly as point sources. But technological, economic, and political realities make such regulation impractical. Provincial regulators and conservation authorities require other tools to reverse watershed degradation – tools that are adaptable and ensure an efficient use of the resources. WQT has proven to be a successful alternative that increases water quality in a cost-effective manner compared to the technological upgrades typically required by command-and-control regulation (Selman et al., 2009). As WQT works in combination with regulation, it helps regulated sources meet/exceed their standards at lower costs and allows new or expanding regulated entities to operate within watershed limits.

Involving non-point sources in WQT successfully reduces pollution at its origin and can clean up multiple toxins at once (O'Grady, 2011). Whereas technological upgrades to point sources often target single contaminants (if those contaminants exceed the regulated limit), non-point source applications can reduce all contaminants affecting a waterbody through simpler pollution reduction strategies.

Benefits of WQT include not only improving water quality but also strengthening community relationships. As different sectors work together to solve environmental problems, members of the community build trust in one another. When all parties are able to voice their opinion and are invited to partake in solving a problem, strong relationships are formed. These relationships, which regulatory guidelines may never have formed, are necessary for achieving successful water quality improvement initiatives.

The biggest impediment to WQT is the lack of public knowledge of its benefits. Without public support, WQT programs take longer to get established and cost more than necessary. Positive case studies, continued education, and the enforcement of tough water regulations should reduce skepticism associated with WQT, fostering more program support across the province (O'Grady, 2011).

References

Baumol, W.J., and W.E. Oates. 1988. *The Theory of Environmental Policy*. 2nd edition. Cambridge and New York: Cambridge University Press.

Chestnut, L.G. and D.M. Mills. 2005. “A Fresh Look at the Benefits and Costs of the US Acid Rain Program.” *Journal of Environmental Management* 77: 252-266.

Conservation Ontario. 2003. *Watershed Economic Incentives through Phosphorus Trading and Water Quality*. Retrieved from: http://www.conservationontario.ca/projects/pdf/reports/PHASE%20I/watershed_economic_incentives.pdf

Dimock, H.G. 1997. *Factors in Working with Groups*. Montreal: Sir George Williams University.

Earles, T., W. Lorenz, W. Koger, and M. Trujillo. 2008. “Nonpoint Source Phosphorus Trading in the Cherry Creek Reservoir Watershed in Colorado.” *J. Irrig. Drain Eng.* 134, Special Issue: Urban Storm-Water Management, 589–597.

Environment Canada. 2013. “Agents of Change: South Nation Conservation.” Retrieved from http://www.ec.gc.ca/p2/default.asp?lang=En&n=21E379B9-1

Environmental Defense. 2000. *From Obstacle to Opportunity: How acid rain emissions trading is delivering cleaner air*.

Feath, P. 2000. *Fertile Ground: Nutrient trading’s potential to cost-effectively improve water quality*. Washington, DC: World Resources Institute.

Great Lakes Water Quality Board. 1989. *1989 Report of Great Lakes Water Quality*. Windsor, ON: International Joint Commission.

Hamilton, K. 2006. *Testing the Waters: The Great Miami River Watershed Water Quality Credit Trading Program*. Ecosystem Marketplace. Retrieved from: http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=4568&section=home&eod=1

Horne, M. 2008. *Cap and Trade: Reducing Pollution, Inspiring Innovation*. British Columbia Global Warming Solution Series. The Pembina Institute.

Kasssirer, J. 2013. *South Nation Conservation Total Phosphorus Management Program Review*. Cullbridge Marketing and Communications.

Ludwig, L.C. 2004. “The US Acid Rain Program and Its Effect on SO2 Emission Levels.” *Issues in Political Economy* 13.

Ministry of the Environment. 1994. *Water Management Policies, Guidelines, Provincial Water Quality Objectives*. Queen's Printer for Ontario.

Ministry of the Environment. 2009. *Lake Simcoe Protection Plan*. Queen's Printer for Ontario. Retrieved from: http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_076302.pdf\

National Association of Clean Air Agencies. 2005. *Don't Take Away a State's Right to Protect Its Citizens from Dirty Air*. Retrieved from: http://www.4cleanair.org/FinalBrochure-April05.pdf

O'Grady, D. 2008. "Point to non-point phosphorus trading in the South Nation River watershed." *WIT Transactions on Ecology and the Environment* 108. WIT Press.

O'Grady, D. 2011. "Sociopolitical conditions for successful water quality trading in the South Nation River watershed, Ontario, Canada." *Journal of the American Water Resources Association* 47, no. 1: 39-51.

O'Grady, D. 2013A. Personal Communication. General Manager/Secretary-Treasurer, South Nation Conservation Authority. May 7, 2013.

O'Grady, D. 2013B. Personal Communication. General Manager/Secretary-Treasurer, South Nation Conservation Authority. May 14, 2013.

O'Grady, D. and W.A. Wilson. No Date. "Phosphorus Trading in the South Nation River Watershed, Ontario, Canada." Available at: www.envtn.org/uploads/ontario.PDF

Ogilvie, Ogilvie & Company. 2013. *Citizen's Guide to Water Quality Trading*. Lake Simcoe Region Conservation Authority, Prototype v.3. Retrieved through personal communication with Mike Walters, General Manager of Watershed Management at the Lake Simcoe Region Conservation Authority.

Schmalensee, R., P.L. Joskow, A.D, Ellerman, J.P. Montero, and E.M. Bailey, 1998. "An Interim Evaluation of Sulfur Dioxide Emissions Trading." *Journal of Economic Perspectives* 12 (Summer): 53-68.

Selman, M., S. Greenhalgh, E. Branosky, C. Jones, and J. Guiling. 2009. *Water quality trading programs – an international overview.* World Resource Institute Issue Brief.

SNCA (South Nation Consevation Authority). 2007. *2006 Clean Water Program Annual Report, Appendix A: 2006 Education and Promotional Material*.

SNCA (South Nation Conservation Authority). 2009. *TPM Program Summary for North Glengarry*. Available at: www.nation.on.ca/pdf/2006 Clean Water Program Annual Report.Appendix A.pdf

SNCA (South Nation Conservation Authority). 2010. *Clean Water Program: 2009 Annual Report*. Retrieved from: http://www.nation.on.ca/pdf/2009%20Annual%20CWP%20Report.Final.July%202010.pdf

Sustainable Prosperity. 2011. *Economic Instruments for Water Management in Canada: Case studies and barries to implementation*. Policy Brief.

United Nations Environment Programme. 2002. *An Emerging Market for the Environment: A Guide to Emissions Trading*. United Nations Publications. Division of Technology, Industry and Economics.

Walters, M. 2013. Personal Communication. General Manager, Watershed Management at Lake Simcoe Region Conservation Authority. April 29, 2013.

Weersink, A., J. Livernois, J. F. Shogren, and J. S. Shortle. 1998. "Economic Intruments and Environmental Policy in Agriculture." *Canadian Public Policy – Analyse de Politiques* 24, no. 3: 309-327.

Woodward, R.T., R.A. Kaiser, and A.M. Wicks. 2002. "The Structure and Practice of Water Quality Trading Markets." *Journal of the American Water Resources Association* 38(4): 967-980.

XCG (Environmental Engineers and Scientists) and Kieser & Associates (Environmental Science and Engineering). 2010. *Water Quality Trading in the Lake Simcoe Watershed: Feasibility Study*. Retrieved from: www.ene.gov.on.ca/stdprodcomsume/groups/lr/@ene/@local/@simcoeprotection/documents/nativedocs/stdprod_092637.pdf

Yandle, B. 2008. "Markets for water quality." *PERC Reports* 26, no. 3, 14-17.